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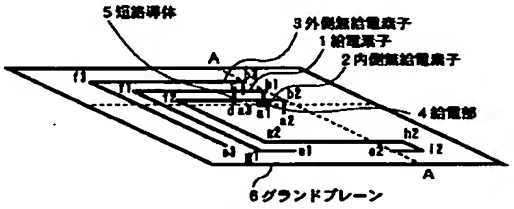
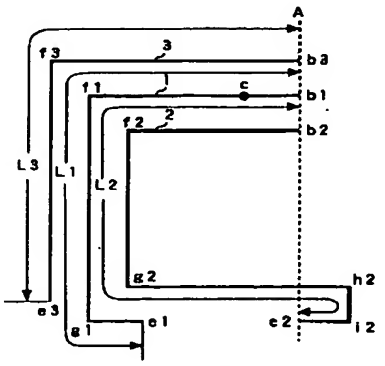
(54)【発明の名称】　逆Ｆ型アンテナ

(57)【要約】
【課題】　小型にしても広帯域性を有する逆Ｆ型アンテナとする。
【解決手段】　屈曲した給電素子１の外側に平行に外側無給電素子３を屈曲して配置し、屈曲した給電素子１の内側に平行に内側無給電素子２を屈曲して配置する。給電素子１と外側無給電素子３の素子長は等しくされ、内側無給電素子２の素子長はこれより長くされている。これにより、各素子を屈曲して小型化しても、広帯域の周波数特性とすることができる。



(a)



(b)

【特許請求の範囲】
【請求項１】　グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が前記グランドプレーンに向かって略垂直に屈曲されて給電部が形成された給電素子と、
前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその外側に略平行に配置された外側無給電素子と、
前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその内側に略平行に配置された内側無給電素子と、
前記グランドプレーンに略垂直に配置されて、前記給電素子の所定位置と前記グランドプレーン間を短絡する短絡素子とを備え、
前記給電素子と前記外側無給電素子の素子長がほぼ等しくされていると共に、前記内側無給電素子の素子長が前記給電素子の素子長より長くされていることを特徴とする逆Ｆ型アンテナ。
【請求項２】　前記内側無給電素子の開放された先端が前記給電素子の開放された先端に向かって屈曲されることにより、小型化されるよう屈曲されていることを特徴とする請求項１記載の逆Ｆ型アンテナ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、広い周波数帯域で動作させることのできる小型の逆Ｆ型アンテナに関するものである。
【０００２】
【従来の技術】室内や地下等で使用されている防災無線、構内無線、移動体無線等のアンテナとしては、従来ダイポール方式アンテナ、モノポールアンテナ等が使用されていたが、ダイポール方式アンテナ及びモノポールアンテナについては室内や構内の側壁や天井等から突出した取付状態となるために美観を損ねることになっていた。これを解決するために、低姿勢の平面型のアンテナが提案されている。この平面型のアンテナとして、特開平８－７８９４３号公報や特開平８－２５０９２５号公報に開示される逆Ｆ型アンテナが知られており、その一例の構成を図１１（ａ）に示す。
【０００３】この図に示す逆Ｆ型アンテナは、等価的に無限の大きさとされたグランドプレーン１０６と、このグランドプレーン１０６上に所定間隔離隔されて平行に配置されたＬ字状の給電素子１０１と、給電素子１０１の両側に配置された２本のＬ字状の無給電素子１０２，１０３が設けられている。給電素子１０１の一端は、垂直にグランドプレーン１０６側に屈曲されてその先端が給電部１０４とされており、その他端は開放されている。さらに、給電素子１０１の屈曲位置の近傍の所定位置ｃをグランドプレーン１０６に短絡させる短絡導体１０５が設けられている。また、２本の無給電素子１０２，１０３の一端は、垂直に屈曲されてその先端がグランドプレーン１０６に短絡されており、その他端は開放されている。
【０００４】グランドプレーン１０６のａ点には図示されていないが貫通孔が形成されており、この貫通孔の部分に図示しない同軸接栓が固着され、その外部導体は貫通孔の周りのグランドプレーン１０６に接続され、その内部導体は給電素子１０１の屈曲された先端に接続される。給電素子１０１の全長、すなわち、給電素子１０１の屈曲された一端であるａ点から先端の開放端であるｅ点までの長さａ－ｅは、動作中心周波数の波長をλとするときに、ほぼ１／４λとされている。また、２本の無給電素子１０２，１０３の全長の長さａ’－ｅ’も同様にほぼ１／４λとされている。また、ａ点と短絡導体１０５が設けられるｄ点までの長さａ－ｄを調整することにより、給電点インピーダンスを調整することができる。
【０００５】このような構成の逆Ｆ型アンテナの電気的特性を、図１１（ｂ）（ｃ）（ｄ）に示す。図１１（ｂ）はＶＳＷＲ（電圧定在波比）の周波数特性であり、図１１（ｃ）はφ＝０°の面の水平偏波成分と垂直偏波成分の放射パターンであり、図１１（ｄ）はφ＝９０°の面の水平偏波成分と垂直偏波成分の放射パターンである。なお、図１１（ｃ）（ｄ）における測定周波数は設計周波数をｆｏとする時に、１．０２ｆｏの測定周波数とされており、同図において垂直偏波成分は実線で示されており、水平偏波成分は破線で示されている。図１１（ｂ）に示すように、図１１（ａ）に示す構成の逆Ｆ型アンテナは、広帯域性を示しており、ＶＳＷＲが２以下の比帯域は周波数ｆｏに対して約２０％となる。また、φ＝０°面では水平偏波成分は放射されず垂直偏波成分のみ放射されており、φ＝９０°面では垂直偏波成分はグランドプレーン１０６に対して傾いて放射されるようになり、水平偏波成分は上方へ放射されるようになる。
【０００６】
【発明が解決しようとする課題】図１１（ａ）に示す逆Ｆ型アンテナは比帯域が２０％されるために、広帯域性を要求される携帯電話機にも使用することが可能となる。しかしながら、給電素子１０１および２本の無給電素子１０２，１０３は直線状に延伸された形態とされているため、逆Ｆ型アンテナの形状は大きいものとなる。従って、小型化が特に要求される携帯電話機等に搭載するには形状が大きすぎるという問題点があった。そこで、これを解決する一手法として給電素子１０１と２本の無給電素子１０２，１０３をグランドプレーン１０６

と平行する面内において屈曲させることが考えられる。このような考えに基づく逆Ｆ型アンテナの構成を図１２（ａ）に示す。

【０００７】図１２（ａ）に示す逆Ｆ型アンテナは、等価的に無限の大きさとされたグランドプレーン１１６と、このグランドプレーン１１６上に所定間隔離隔されて平行に配置されており、その一端部がグランドプレーン１１６に対して垂直に屈曲された給電素子１１１と、給電素子１１１の両側に配置された２本の無給電素子１１２，１１３とから構成されている。給電素子１１１の一端は、垂直にグランドプレーン１１６側に屈曲されてその先端が給電部１１４とされており、水平部はグランドプレーン１１６に平行する面において２カ所で図示するように屈曲されて、その他端が開放されている。さらに、給電素子１１１の屈曲位置の近傍の所定位置ｃをグランドプレーン１１６に短絡させる短絡導体１１５が設けられている。

【０００８】また、２本の無給電素子１１２，１１３の一端は、垂直に屈曲されてその先端がグランドプレーン１０６に短絡されており、水平部はグランドプレーン１１６に平行する面において１カ所あるいは２カ所で図示するように屈曲されて、その先端が開放されている。この場合、屈曲された２本の無給電素子１１２，１１３は、屈曲された給電素子１１１に平行に配置されるようになる。この逆Ｆ型アンテナの給電構造は、図１１（ａ）に示す逆Ｆ型アンテナと同様の構成とされているので省略する。給電素子１１１の全長、すなわち、給電素子１１１の屈曲された一端であるａ点から先端の開放端であるｅ点までの長さａ－ｅは、動作中心周波数の波長をλとするときに、ほぼ１／４λとされている。また、２本の無給電素子１１２，１１３の全長の長さａ’－ｅ’も同様にほぼ１／４λとされている。また、ａ点と短絡導体１１５が設けられるｄ点までの長さａ－ｄを調整することにより、給電点インピーダンスを調整することができる。

【０００９】このような構成の逆Ｆ型アンテナの電気的特性を、図１２（ｂ）（ｃ）（ｄ）に示す。図１２（ｂ）はＶＳＷＲ（電圧定在波比）の周波数特性であり、図１２（ｃ）はφ＝０°の面の水平偏波成分と垂直偏波成分の放射パターンであり、図１２（ｄ）はφ＝９０°の面の水平偏波成分と垂直偏波成分の放射パターンである。なお、図１２（ｃ）（ｄ）における測定周波数は設計周波数ｆｏとする時に、１．１ｆｏの測定周波数とされており、同図において垂直偏波成分は実線で示されており、水平偏波成分は破線で示されている。図１２（ｂ）に示すように、図１２（ａ）に示す構成の逆Ｆ型アンテナは、動作周波数帯域は低域と高域とで２分されるようになる。また、φ＝０°面では水平偏波成分は若干放射され、垂直偏波成分は傾いて放射される。ただし、利得は小さくなり、特に水平偏波成分に対する利得は小さい。さらに、φ＝９０°面ではφ＝０°面と同様に水平偏波成分は若干放射され、垂直偏波成分は傾いて放射される。ただし、利得は小さくなり、特に水平偏波成分に対する利得は小さい。

【００１０】図１２（ａ）に示す逆Ｆ型アンテナは、給電素子１１１および２本の無給電素子１１２，１１３がグランドプレーンと平行な面内において屈曲されているため、小型の逆Ｆ型アンテナとすることができる。しかしながら、動作周波数帯域は２分されてしまうことから広帯域性を得ることができないという問題があった。そこで、本発明は小型にしても広帯域性を有する逆Ｆ型アンテナを提供することを目的としている。

【００１１】

【課題を解決するための手段】上記目的を達成するために、本発明の逆Ｆ型アンテナは、グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が前記グランドプレーンに向かって略垂直に屈曲されて給電部が形成された給電素子と、前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその外側に略平行に配置された外側無給電素子と、前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその内側に略平行に配置された内側無給電素子と、前記グランドプレーンに略垂直に配置されて、前記給電素子の所定位置と前記グランドプレーン間を短絡する短絡素子とを備え、前記給電素子と前記外側無給電素子の素子長がほぼ等しくされていると共に、前記内側無給電素子の素子長が前記給電素子の素子長より長くされている。

【００１２】また、上記逆Ｆ型アンテナにおいて、前記内側無給電素子の開放された先端が前記給電素子の開放された先端に向かって屈曲されることにより、小型化されるよう屈曲されていてもよい。

【００１３】このような本発明によれば、給電素子と２本の無給電素子とをグランドプレーンと平行な面内において屈曲するようにした際に、内側に位置する無給電素子の長さを長くしたので、動作周波数帯域が２分されることなく広帯域性を有する逆Ｆ型アンテナとすることができる。また、給電素子と２本の無給電素子とは屈曲されているので、小型の逆Ｆ型アンテナとすることができる。

【００１４】

【発明の実施の形態】本発明の逆Ｆ型アンテナの実施の形態の第１の構成例を図１（ａ）（ｂ）に示す。ただし、図１（ａ）は本発明の第１の逆Ｆ型アンテナの斜視図であり、図１（ｂ）は本発明の第１の逆Ｆ型アンテナの上面図である。これらの図に示す逆Ｆ型アンテナは、

等価的に無限の大きさとされたグランドプレーン６と、このグランドプレーン６上に配置された給電素子１と、給電素子１の両側にそれぞれ配置された内側無給電素子２と外側無給電素子３とから構成される。給電素子１は、グランドプレーン６に対して略垂直とされた垂直部ａ１－ｂ１と屈曲された水平部ｂ１－ｆ１－ｇ１－ｅ１から構成される。また、内側無給電素子２は、グランドプレーン６に対して略垂直とされた垂直部ａ２－ｂ２と屈曲された水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２から構成され、外側無給電素子３はグランドプレーン６に対して略垂直とされた垂直部ａ３－ｂ３と屈曲された水平部ｂ３－ｆ３－ｅ３から構成される。

【００１５】給電素子１の垂直部ａ１－ｂ１の一端は給電部４とされており、水平部ｂ１－ｆ１－ｇ１－ｅ１はグランドプレーン６に平行する面において２カ所で図示するように屈曲されて、その先端が開放されている。さらに、給電素子１における垂直部と水平部との接続点ｂ１の近傍の所定位置ｃをグランドプレーン６に短絡させる短絡導体５が設けられている。短絡導体５の長さｃ－ｄは垂直部ａ１－ｂ１の長さとほぼ等しくされ、これにより、給電素子１は垂直部ａ１－ｂ１の長さに相当する間隔だけグランドプレーン６から離隔されて、グランドプレーン６の面に平行に配置される。また、給電素子１の垂直部の先端ａ１に対向するグランドプレーン６の部分には、図示されていないが貫通孔が形成されており、この貫通孔の部分に図示しない同軸接栓が固着され、その外部導体は貫通孔の周りのグランドプレーン６に接続され、その内部導体は給電素子１の垂直部の先端ａ１に接続される。

【００１６】内側無給電素子２の垂直部ａ２－ｂ２のａ２点はグランドプレーン６に短絡され、水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２は、図示するように４カ所で屈曲され、その先端が開放されている。この内側無給電素子２における屈曲は、給電素子１に内側無給電素子２がグランドプレーン６に平行な面内において一定の間隔を保持して平行になるように屈曲されている。なお、内側無給電素子２は垂直部ａ２－ｂ２の長さに相当する間隔だけグランドプレーン６から離隔されて、グランドプレーン６の面に平行に配置される。

【００１７】さらに、外側無給電素子３の垂直部ａ３－ｂ３のａ３点はグランドプレーン６に短絡され、水平部ｂ３－ｆ３－ｅ３は、図示するように１カ所で屈曲され、その先端が開放されている。この外側無給電素子３における屈曲は、給電素子１に外側無給電素子３がグランドプレーン６に平行な面内において一定の間隔を保持して平行になるように屈曲されている。なお、外側無給電素子３は垂直部ａ３－ｂ３の長さに相当する間隔だけグランドプレーン６から離隔されて、グランドプレーン６の面に平行に配置される。また、給電素子１と内側無給電素子２と外側無給電素子３における水平部の始点ｂ１，ｂ２，ｂ３は直線であるＡ－Ａ線上に位置するようにされ、内側無給電素子２における屈曲点ｈ２と屈曲点ｉ２とは、図示するようにＡ－Ａ線を超えた位置に配置されている。

【００１８】ところで、給電素子１の垂直部ａ１－ｂ１と内側無給電素子２の垂直部ａ２－ｂ２と外側無給電素子３の垂直部ａ３－ｂ３と短絡導体５の長さは相互にほぼ等しくされ、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１の長さと、外側無給電素子３の水平部ｂ３－ｆ３－ｅ３の長さとはほぼ等しくされる。また、内側無給電素子２の水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２の長さは、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１の長さより長く設定される。例えば、設計周波数１．２〔ＧＨｚ〕の波長をλｏとした際に、給電素子１の垂直部ａ１－ｂ１と内側無給電素子の垂直部ａ２－ｂ２と外側無給電素子の垂直部ａ３－ｂ３と短絡導体５の長さは、約０．０９１２λｏとされ、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１と、外側無給電素子３の水平部ｂ３－ｆ３－ｅ３の長さは、約０．１７６λｏとされ、内側無給電素子２の水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２の長さは、約０．２２３λｏとされる。また、短絡導体５と給電点ａ１との長さａ１－ｄは、約０．０３５２λｏとされ、給電素子１および内側無給電素子２との間隔ａ１－ａ２と、給電素子１と外側無給電素子３との間隔ａ１－ａ３は約０．０１３λｏとされる。さらに、給電素子１および内側無給電素子２、外側無給電素子３、短絡導体５は、例えば直径約０．００４λｏの線材で構成される。

【００１９】図１（ａ）（ｂ）に示す本発明の第１の逆Ｆ型アンテナにおける内側無給電素子２の水平部におけるｂ２－ｆ２の長さとｆ２－ｇ２の長さとｇ２からＡ－Ａ線に接するまでの長さがほぼ等しくなるよう屈曲し、この内側無給電素子２に対して、グランドプレーン６に平行な面内において一定の間隔を保持して平行になるように、上記した素子長の給電素子１と外側無給電素子３とを屈曲させた際の電気的特性を、図２および図３に示す。ただし、図２は逆Ｆ型アンテナのインピーダンス特性を示すスミスチャートであり、図３はＶＳＷＲの周波数特性を示している。また、φ＝０°面における放射パターンを図８に示している。図２および図３を参照すると、ＶＳＷＲは低域において多少２分される傾向を示すが、ＶＳＷＲが３以下となる比帯域は約２９％もの広帯域とされることがわかる。このように、本発明の第１の逆Ｆ型アンテナは給電素子１および内側無給電素子２と外側無給電素子３とを屈曲して小型化を図るようにしても、比帯域を広帯域とすることができることから、携帯電話機等の小型化・広帯域性を必要とされる通信システムに適用して好適なアンテナとすることができる。

【００２０】ここで、給電素子１および２本の無給電素子２，３をグランドプレーン６と平行な面内において屈

曲しても、本発明の第１の逆Ｆ型アンテナは図１２（ｂ）に示す従来例のようにＶＳＷＲの周波数特性が２分されずに広帯域になる理由について説明する。図１２（ａ）に示す構成の逆Ｆ型アンテナを種々の手法により解析したところ、図１２（ｂ）に示す低域の共振周波数ｆLを含む周波数特性は外側に配置された無給電素子１１２の作用により奏されるものであり、図１２（ｂ）に示す２分された高域における低い方の共振周波数ｆH近傍の周波数特性は内側に配置された無給電素子１１３の作用により奏されることがわかった。さらに、給電素子１１１と無給電素子１１３との作用により２分された高域における広帯域の周波数特性が奏されている。ここで、共振周波数ｆHを低域へシフトするようにすれば、共振周波数ｆHが共振周波数ｆLに近接されるので、周波数特性は２分されずに広帯域の周波数特性とすることができるようになる。これを実現するために、本発明の第１の逆Ｆ型アンテナでは内側無給電素子２の素子長を長くして共振周波数ｆHを低域へシフトするようにしている。

【００２１】次に、本発明の逆Ｆ型アンテナの実施の形態の第２の構成例を図４および図５に示す。ただし、図４は本発明の第２の逆Ｆ型アンテナの斜視図であり、図５は本発明の第２の逆Ｆ型アンテナの上面図である。図４および図５に示す第２の逆Ｆ型アンテナは、次の点で図１（ａ）（ｂ）に示す第１の逆Ｆ型アンテナと異なる構成とされている。図１（ａ）（ｂ）に示す本発明の第１の逆Ｆ型アンテナでは、給電素子１と内側無給電素子２と外側無給電素子３における水平部の始点ｂ１，ｂ２，ｂ３はＡ－Ａ線上に位置するようにされ、内側無給電素子２における屈曲点ｈ２と屈曲点ｉ２とは、図示するようにＡ－Ａ線を超えた位置に配置されている。これに対して、図４および図５に示す第２の逆Ｆ型アンテナは、給電素子１と内側無給電素子２と外側無給電素子３における水平部の始点ｂ１，ｂ２，ｂ３はＡ－Ａ線上に位置するようにされると共に、内側無給電素子２における屈曲点ｈ２と屈曲点ｉ２も、図示するようにＡ－Ａ線上の位置に配置されるよう、水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２が屈曲されている。

【００２２】その他の構成においては、本発明の第２の逆Ｆ型アンテナは本発明の第１の逆Ｆ型アンテナと同様の構成とされているので、その説明は省略する。この本発明の第２の逆Ｆ型アンテナにおける給電素子１の垂直部ａ１－ｂ１と内側無給電素子２の垂直部ａ２－ｂ２と外側無給電素子３の垂直部ａ３－ｂ３と短絡導体５の長さは相互にほぼ等しくされ、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１の長さと、外側無給電素子３の水平部ｂ３－ｆ３－ｅ３の長さとはほぼ等しくされる。また、内側無給電素子２の水平部の長さは、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１の長さより長く設定される。例えば、設計周波数１．２〔ＧＨｚ〕の波長をλｏとした際に、給電素子１の垂直部ａ１－ｂ１と内側無給電素子２の垂直部ａ２－ｂ２と外側無給電素子３の垂直部ａ３－ｂ３と短絡導体５の長さは、約０．０９１２λｏとされ、給電素子１の水平部ｂ１－ｆ１－ｇ１－ｅ１と、外側無給電素子３の水平部ｂ３－ｆ３－ｅ３の長さは、約０．１７６λｏとされ、内側無給電素子２の水平部ｂ２－ｆ２－ｇ２－ｈ２－ｉ２－ｅ２の長さは、約０．２２３λｏとされる。また、短絡導体５と給電点ａ１との長さａ１－ｄは、約０．０３５２λｏとされ、給電素子１および内側無給電素子２との間隔ａ１－ａ２と、給電素子１と外側無給電素子３との間隔ａ１－ａ３は約０．０１３λｏとされる。さらに、給電素子１および内側無給電素子２、外側無給電素子３、短絡導体５は、例えば直径約０．００４λｏの線材で構成される。

【００２３】図４および図５に示す本発明の第２の逆Ｆ型アンテナにおける内側無給電素子２の水平部におけるｂ２－ｆ２の長さとｆ２－ｇ２の長さとｇ２－ｈ２の長さがほぼ等しくなるよう屈曲し、この内側無給電素子２に対して、グランドプレーン６に平行な面内において一定の間隔を保持して平行になるように、上記した素子長の給電素子１と外側無給電素子３とを屈曲させた際の電気的特性を、図６，図７および図８に示す。ただし、図６は逆Ｆ型アンテナのＶＳＷＲの周波数特性であり、図７はそのインピーダンス特性を示すスミスチャートである。図６および図７を参照すると、ＶＳＷＲは低域においてほとんど２分される傾向がなくなっており、ＶＳＷＲが３以下となる比帯域は約２７％もの広帯域とされることがわかる。このように、本発明の第２の逆Ｆ型アンテナは給電素子１および内側無給電素子２と外側無給電素子３とを屈曲して小型化を図るようにしても、比帯域を広帯域とすることができることから、携帯電話機等の小型化・広帯域性を必要とされる通信システムに適用して好適なアンテナとすることができる。

【００２４】上記した本発明にかかる逆Ｆ型アンテナの給電素子１および内側無給電素子２と外側無給電素子３は線材で構成すると説明したが、本発明はこれに限らず金属材からなる線条や、細長い帯状の板または管等で形成することもできる。ところで、いずれの材料で本発明にかかる逆Ｆ型アンテナを形成する場合にも、その材料の太さや強度からみて、逆Ｆ型アンテナの給電素子１および内側無給電素子２と外側無給電素子３の各水平部の姿勢を、所要の機械的強度で水平に維持し続けるほど強固に構成することは困難である。そこで、これを解決するために、給電素子１および内側無給電素子２と外側無給電素子３とグランドプレーン６との間に誘電率の低いスペーサを介在させ、このスペーサの下面をグランドプレーン６の表面に固定すると共に、スペーサの上面に逆Ｆ型アンテナの給電素子１および内側無給電素子２と外側無給電素子３を固着するようにしてもよい。この場合、スペーサの側面に給電素子１および内側無給電素子

２と外側無給電素子３における各垂直部を固着し、スペーサを貫通するよう短絡導体５を取り付ければよい。これにより、機械的強度を大きくすることができ、逆Ｆ型アンテナの給電素子１および内側無給電素子２と外側無給電素子３の各水平部の姿勢を、グランドプレーン６に対して平行に維持し続けることができる。

【００２５】また、給電点ａ１に対向してグランドプレーン６に形成した貫通孔の周囲に、高周波特性の良好な絶縁物を充填して接栓の中心導体がグランドプレーン６に接触しないようにしてもよい。さらに、本発明に係る逆Ｆ型アンテナの給電素子１および内側無給電素子２と外側無給電素子３の各水平部を、直方体状の誘電体の上面に蒸着等の手段によって形成した金属薄層により形成し、誘電体の側面に同様の手段により給電素子１および内側無給電素子２と外側無給電素子３の各垂直部を形成する。さらに加えて、誘電体に設けた貫通孔内に同様の手段により金属薄層を形成することにより短絡導体５を形成する。そして、誘電体の下面に所定面積の金属板を固着するか、あるいは、誘電体の下面全域に金属薄層を形成してグランドプレーン６とすることにより、本発明の逆Ｆ型アンテナを構成するようにしてもよい。

【００２６】上記説明した本発明の第１の逆Ｆ型アンテナにおいては、短絡導体５と給電点ａ１との長さａ１－ｄは約０．０３５２λｏとされているが、この長さａ１－ｄをパラメータとした際の電気的特性の変化を図９および図１０に示す。図９（ａ）は、短絡導体５と給電点ａ１との長さａ１－ｄを約０．０２λｏとした際の逆Ｆ型アンテナのインピーダンス特性を示すスミスチャートであり、図９（ｂ）はそのＶＳＷＲの周波数特性を示している。図９（ａ）（ｂ）を参照すると、ＶＳＷＲは低域において２分される傾向が強く、比帯域も狭い。また、図７に示すインピーダンス特性と比較すると明らかなようにインピーダンス特性も変化している。

【００２７】また図１０（ａ）は、短絡導体５と給電点ａ１との長さａ１－ｄを約０．０５２λｏとした際の逆Ｆ型アンテナのインピーダンス特性を示すスミスチャートであり、図１０（ｂ）はそのＶＳＷＲの周波数特性を示している。図１０（ａ）（ｂ）を参照すると、ＶＳＷＲは低域において２分される傾向は小さく、ＶＳＷＲが３以下の比帯域も広い。また、図７に示すインピーダンス特性と比較すると明らかなようにインピーダンス特性も変化している。上記例示された約０．０３５２λｏとされている短絡導体５と給電点ａ１との長さａ１－ｄは、図９と図１０に示す場合の間の数値とされており、図９と図１０に示す比帯域より広い比帯域が得られていると共に、そのインピーダンス特性も良好な特性となる。このように、短絡導体５と給電点ａ１との長さａ１－ｄは例示された数値の近傍とするのが好適である。

【００２８】

【発明の効果】本発明の逆Ｆ型アンテナは以上のように構成されて、給電素子と２本の無給電素子とをグランドプレーンと平行な面内において屈曲するようにした際に、内側に位置する無給電素子の長さを長くされているので、動作周波数帯域が２分されることなく広帯域性を有する逆Ｆ型アンテナとすることができる。また、給電素子と２本の無給電素子とは屈曲されているので、小型の逆Ｆ型アンテナとすることができる。

【図面の簡単な説明】

【図１】本発明の逆Ｆ型アンテナの実施の形態における第１の構成例の構成を示す斜視図、および、上面図である。

【図２】本発明の第１の逆Ｆ型アンテナのインピーダンス特性を示すスミスチャートである。

【図３】本発明の第１の逆Ｆ型アンテナのＶＳＷＲの周波数特性を示す図である。

【図４】本発明の逆Ｆ型アンテナの実施の形態における第２の構成例の構成を示す斜視図である。

【図５】本発明の逆Ｆ型アンテナの実施の形態における第２の構成例の構成を示す上面図である。

【図６】本発明の第２の逆Ｆ型アンテナのＶＳＷＲの周波数特性を示す図である。

【図７】本発明の第２の逆Ｆ型アンテナのインピーダンス特性を示すスミスチャートである。

【図８】本発明の第１の逆Ｆ型アンテナの放射パターンを示す図である。

【図９】本発明の逆Ｆ型アンテナにおいて、短絡導体の位置を給電点に対して変化させた際のインピーダンス特性を示すスミスチャートである。

【図１０】本発明の逆Ｆ型アンテナにおいて、短絡導体の位置を給電点に対して変化させた際の他のインピーダンス特性を示すスミスチャートである。

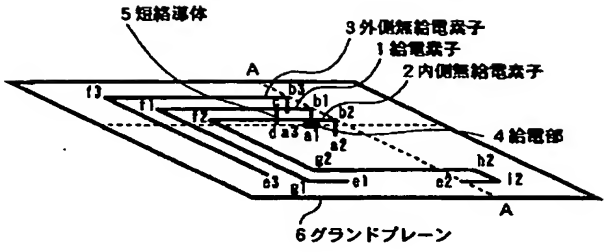
【図１１】従来の逆Ｆ型アンテナの構成、ＶＳＷＲの周波数特性、放射パターンを示す図である。

【図１２】従来の他の逆Ｆ型アンテナの構成、ＶＳＷＲの周波数特性、放射パターンを示す図である。

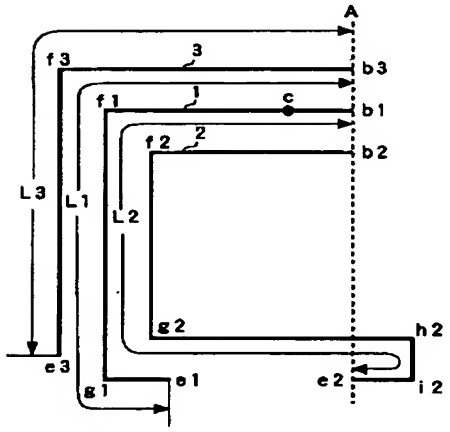
【符号の説明】

１，１０１，１１１　給電素子
２　内側無給電素子
３　外側無給電素子
４，１０４，１１４　給電部
５，１０５，１１５　短絡導体
６，１０６，１１６　グランドプレーン
１１２，１１３　無給電素子

【図１】

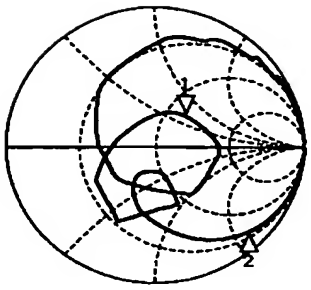


(a)



(b)

【図２】



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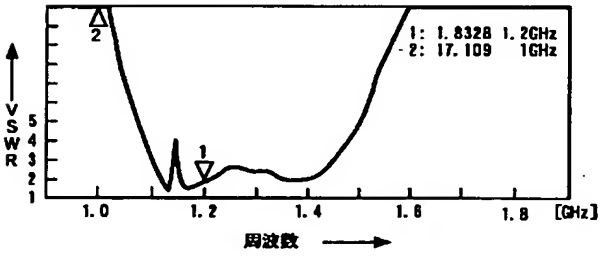

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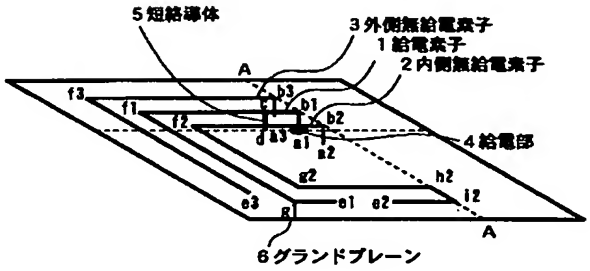

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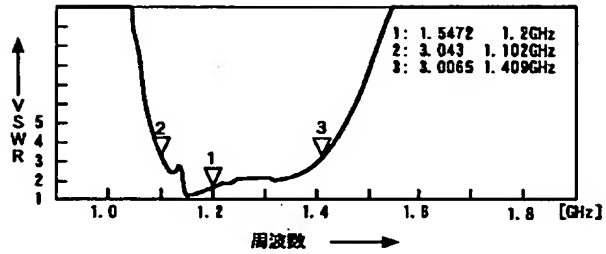

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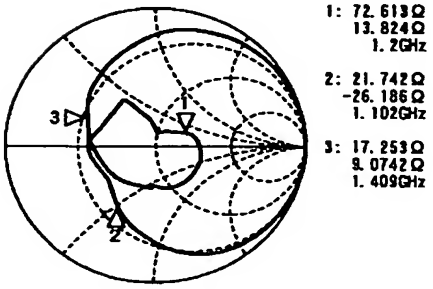

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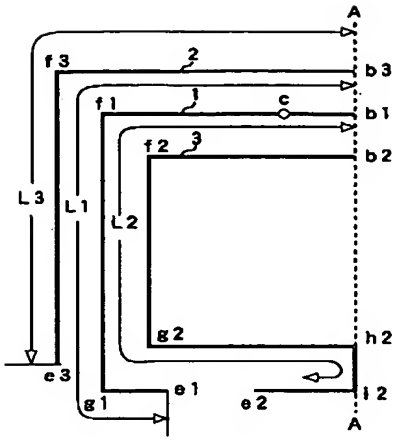
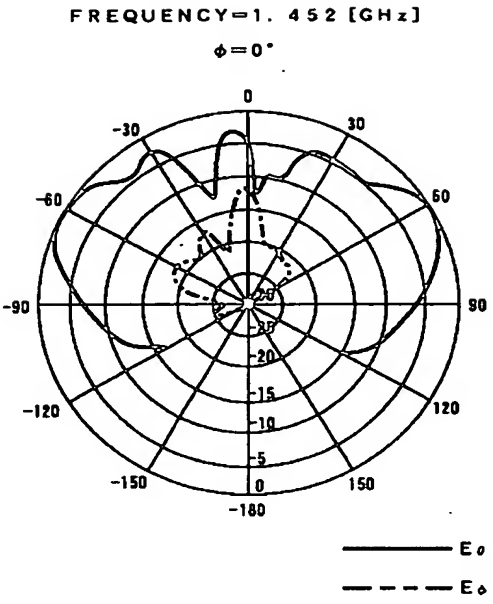


(b)

【図８】



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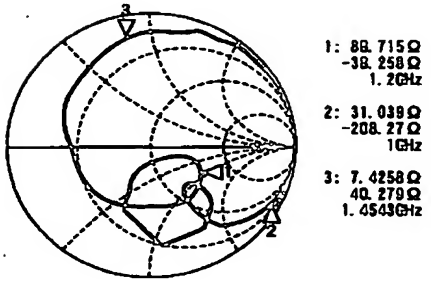
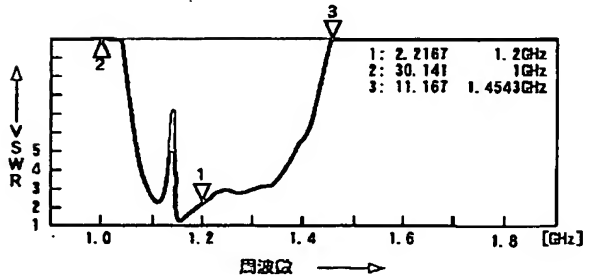
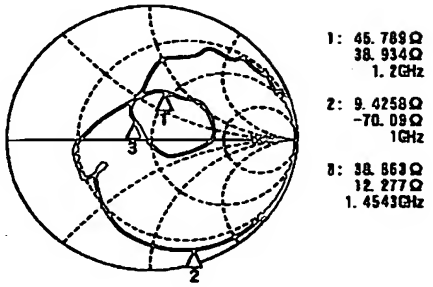


(a)



(b)

【図１０】



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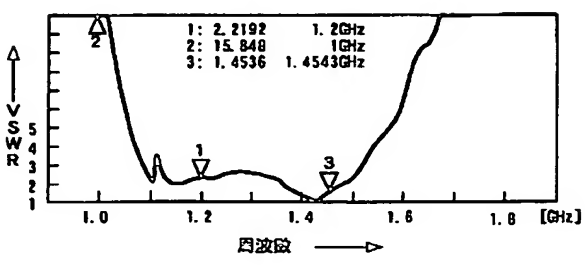

(b)

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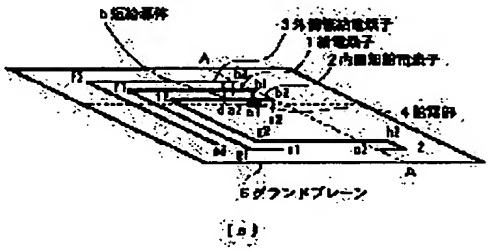
(54) INVERTED F-TYPE ANTENNA

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain an inverted F-type antenna which has a wide band characteristics though being made small-sized.
SOLUTION: An outer passive element 3 is bent and arranged in parallel with a bent feed element 1 on the outside of this element 1, and an inner passive element 2 is bent and arranged in parallel with the bent feed element 1 on the inside of this element 1. The same element length is given to the feed element 1 and the outer passive element 3, and the element length of the inner passive element is made longer. Thus, a wide-band frequency characteristics is obtained though each element is bent and miniaturized.



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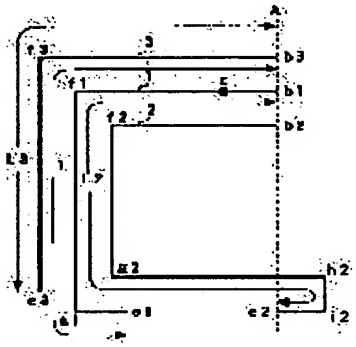

(b)

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] A reverse female mold antenna with which element length of said inside passive element is characterized by being made longer than element length of said electric supply element while having the following and making almost equal element length of said electric supply element and said outside passive element. An electric supply element in which the end was crooked in an abbreviation perpendicular toward said ground plane, and the electric supply section was formed while being crooked in a field of a ground plane, and an parallel field by which predetermined gap isolation was carried out An outside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged on the outside at abbreviation parallel while being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An inside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged at abbreviation parallel at the inside while being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out A short circuit element which is arranged at an abbreviation perpendicular at said ground plane, and short-circuits between a predetermined location of said electric supply element, and said ground plane
[Claim 2] A reverse female mold antenna according to claim 1 characterized by being crooked so that it may be miniaturized, when a tip where said inside passive element was opened wide is crooked toward a tip where said electric supply element was opened wide.

[Translation done.]

* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the small reverse female mold antenna which can be operated in a large frequency band.
[0002]
[Description of the Prior Art] Since it will be in the attachment condition projected from a side wall, a ceiling, etc. of the interior of a room or premises about the dipole method antenna and the monopole antenna, the fine sight was to be spoiled as antennas, such as disaster prevention wireless currently used in the interior of a room, underground, etc., yard wireless, and mobile wireless, although the dipole method antenna, the monopole antenna, etc. were used conventionally. In order to solve this, the antenna of a low-profile plane mold is proposed. As this plane type of an antenna, the reverse female mold antenna indicated by JP,8-78943,A and JP,8-250925,A is known, and the configuration of that example is shown in drawing 11 (a).
[0003] The electric supply element 101 of the shape of L character which predetermined gap isolation of the reverse female mold antenna shown in this drawing was carried out on the ground plane 106 made into the magnitude of infinity equivalent and this ground plane 106, and has been arranged in parallel, and the passive element 102,103 of the two shape of L character arranged at the both sides of the electric supply element 101 are formed. The end of the electric supply element 101 is perpendicularly crooked in a ground plane 106 side, the tip is made into the electric supply section 104, and the other end is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the crookedness location of the electric supply element 101 with a ground plane 106 -- the conductor 105 is formed. Moreover, the end of two passive elements 102,103 was crooked perpendicularly, the tip has connected it with the ground plane 106 too hastily, and the other end is opened wide.
[0004] Although not illustrated by a points of a ground plane 106, the through tube is formed, the coaxial plug which is not illustrated into the portion of this through tube fixes, that outer conductor is connected to the surrounding ground plane 106 of a through tube, and that inner conductor is connected at the tip at which the electric supply element 101 was crooked. When setting wavelength of working heart frequency to lambda, the overall length of the electric supply element 101, i.e., length a-e from a points which are the ends at which the electric supply element 101 was crooked to e points which are the open ends at a tip, is set to about 1/4lambda. Moreover, length a'-e' of the overall length of two passive elements 102,103 is similarly set to about 1/4lambda. moreover, a points and a short circuit -- feeding point impedance can be adjusted by adjusting length a-d to d points in which a conductor 105 is formed.
[0005] The electrical characteristics of such a reverse female mold antenna of a configuration are shown in drawing 11 (b), (c), and (d). Drawing 11 (b) is the frequency characteristic of VSWR (voltage standing wave ratio), drawing 11 (c) is the radiation pattern of the horizontally-polarized-wave component of a phi= 0-degree field, and a vertically-polarized-wave component, and drawing 11 (d) is the radiation pattern of the horizontally-polarized-wave component of a phi= 90-degree field, and a vertically-polarized-wave component. In addition, the test frequency

in drawing 11 (c) and (d) is made into the test frequency of 1.02fo when setting layout frequency to fo, the vertically-polarized-wave component is shown by the continuous line in this drawing, and the horizontally-polarized-wave component is shown by the dashed line. As shown in drawing 11 (b), the reverse female mold antenna of a configuration of being shown in drawing 11 (a) shows broadband nature, and, as for two or less fractional bandwidth, VSWR becomes about 20% to frequency fo. Moreover, in respect of phi= 0 degree, a horizontally-polarized-wave component is not emitted, but only the vertically-polarized-wave component is emitted, a vertically-polarized-wave component inclines to a ground plane 106, and comes to be emitted, and a horizontally-polarized-wave component comes to be emitted upwards in phi= 90-degree side.

[0006]

[Problem(s) to be Solved by the Invention] Since a fractional bandwidth is carried out 20%, the reverse female mold antenna shown in drawing 11 (a) becomes possible [using it also for the portable telephone of which broadband nature is required]. However, since the electric supply element 101 and two passive elements 102,103 are made into the gestalt extended in the shape of a straight line, the configuration of a reverse female mold antenna will become large. Therefore, there was a trouble that a configuration was too large in carrying in the portable telephone with which especially a miniaturization is demanded. Then, it can consider making the electric supply element 101 and two passive elements 102,103 crooked in the field which is parallel to a ground plane 106 as a way method which solves this. The configuration of a reverse female mold antenna based on such an idea is shown in drawing 12 (a).

[0007] The reverse female mold antenna shown in drawing 12 (a) consists of an electric supply element 111 for which predetermined gap isolation is carried out on the ground plane 116 made into the magnitude of infinity equivalent, and this ground plane 116, it is arranged in parallel, and that end section was perpendicularly crooked to the ground plane 116, and two passive elements 112,113 arranged at the both sides of the electric supply element 111. The end of the electric supply element 111 is perpendicularly crooked in a ground plane 116 side, the tip is made into the electric supply section 114, a horizontal level is crooked so that it may illustrate by two places in the field which is parallel to a ground plane 116, and the other end is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the crookedness location of the electric supply element 111 with a ground plane 116 -- the conductor 115 is formed.

[0008] Moreover, the end of two passive elements 112,113 was crooked perpendicularly, the tip has connected it with the ground plane 106 too hastily, a horizontal level is crooked so that it may illustrate by one place or two places in the field which is parallel to a ground plane 116, and the tip is opened wide. In this case, two crooked passive elements 112,113 come to be arranged in parallel with the crooked electric supply element 111. Since it considers as the same configuration as the reverse female mold antenna shown in drawing 11 (a), the electric supply structure of this reverse female mold antenna is omitted. When setting wavelength of working heart frequency to lambda, the overall length of the electric supply element 111, i.e., length a-e from a points which are the ends at which the electric supply element 111 was crooked to e points which are the open ends at a tip, is set to about 1/4lambda. Moreover, length a'-e' of the overall length of two passive elements 112,113 is similarly set to about 1/4lambda. moreover, a points and a short circuit -- feeding point impedance can be adjusted by adjusting length a-d to d points in which a conductor 115 is formed.

[0009] The electrical characteristics of such a reverse female mold antenna of a configuration are shown in drawing 12 (b), (c), and (d). Drawing 12 (b) is the frequency characteristic of VSWR (voltage standing wave ratio), drawing 12 (c) is the radiation pattern of the horizontally-polarized-wave component of a phi= 0-degree field, and a vertically-polarized-wave component, and drawing 12 (d) is the radiation pattern of the horizontally-polarized-wave component of a phi= 90-degree field, and a vertically-polarized-wave component. In addition, the test frequency in drawing 12 (c) and (d) is made into the test frequency of 1.1fo when considering as the layout frequency fo, the vertically-polarized-wave component is shown by the continuous line in this drawing, and the horizontally-polarized-wave component is shown by the dashed line. As shown

in drawing 12 (b), a clock frequency band comes to be carried out for the reverse female mold antenna of a configuration of being shown in drawing 12 (a) in low-pass and a high region for 2 minutes. Moreover, in respect of phi= 0 degree, a horizontally-polarized-wave component is emitted a little, and a vertically-polarized-wave component inclines and is emitted. However, gain becomes small and the gain especially over a horizontally-polarized-wave component is small. Furthermore, in respect of phi= 90 degrees, a horizontally-polarized-wave component is emitted a little like phi= 0-degree side, and a vertically-polarized-wave component inclines and is emitted. However, gain becomes small and the gain especially over a horizontally-polarized-wave component is small.

[0010] Since the electric supply element 111 and two passive elements 112,113 are crooked in the field parallel to a ground plane, the reverse female mold antenna shown in drawing 12 (a) can be used as a small reverse female mold antenna. However, since a clock frequency band will be carried out for 2 minutes, it had the problem that broadband nature could not be obtained. Then, even if this invention is small, it aims at offering the reverse female mold antenna which has broadband nature.

[0011]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, a reverse female mold antenna of this invention While being crooked in a field of a ground plane, and an parallel field by which predetermined gap isolation was carried out While being crooked in an electric supply element in which the end was crooked in an abbreviation perpendicular toward said ground plane, and the electric supply section was formed, a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An outside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged on the outside at abbreviation parallel, While being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An inside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged at abbreviation parallel at the inside, While being arranged at an abbreviation perpendicular at said ground plane, having a short circuit element which short-circuits between a predetermined location of said electric supply element, and said ground plane and making almost equal element length of said electric supply element and said outside passive element Element length of said inside passive element is made longer than element length of said electric supply element.

[0012] Moreover, in the above-mentioned reverse female mold antenna, when a tip where said inside passive element was opened wide is crooked toward a tip where said electric supply element was opened wide, it may be crooked so that it may be miniaturized.

[0013] Since according to such this invention the length of a passive element located inside was lengthened when an electric supply element and two passive elements were made to be crooked in a field parallel to a ground plane, it can consider as a reverse female mold antenna which has broadband nature, without carrying out a clock frequency band for 2 minutes. Moreover, since an electric supply element and two passive elements are crooked, they can be used as a small reverse female mold antenna.

[0014]

[Embodiment of the Invention] The 1st example of a configuration of the gestalt of operation of the reverse female mold antenna of this invention is shown in drawing 1 (a) and (b). However, drawing 1 (a) is the perspective diagram of the 1st reverse female mold antenna of this invention, and drawing 1 (b) is the plan of the 1st reverse female mold antenna of this invention. The reverse female mold antenna shown in these drawings consists of a ground plane 6 made into the magnitude of infinity equivalent, an electric supply element 1 arranged on this ground plane 6, and the inside passive element 2 and the outside passive element 3 which have been arranged at the both sides of the electric supply element 1, respectively. The electric supply element 1 consists of vertical section a1-b1 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b1-f1-g1-e1 which were crooked. Moreover, the inside passive element 2

consists of vertical section a2-b2 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b2-f2-g2-h2-i2-e2 which were crooked, and the outside passive element 3 consists of vertical section a3-b3 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b3-f3-e3 which were crooked.
[0015] The end of vertical section a1-b1 of the electric supply element 1 is made into the electric supply section 4, horizontal level b1-f1-g1-e1 is crooked so that it may illustrate by two places in the field which is parallel to a ground plane 6, and the tip is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the node b1 of the vertical section and horizontal level in the electric supply element 1 with a ground plane 6 -- the conductor 5 is formed. a short circuit -- length c-d of a conductor 5 is made almost equal to the length of vertical section a1-b1, thereby, only the gap equivalent to the length of vertical section a1-b1 is isolated from a ground plane 6, and the electric supply element 1 is arranged in parallel with the field of a ground plane 6. Moreover, although not illustrated by the portion of the ground plane 6 which counters at the tip a1 of the vertical section of the electric supply element 1, the through tube is formed in it, the coaxial plug which is not illustrated into the portion of this through tube fixes, that outer conductor is connected to the surrounding ground plane 6 of a through tube, and that inner conductor is connected at the tip a1 of the vertical section of the electric supply element 1.
[0016] a2 point of vertical section a2-b2 of the inside passive element 2 is connected with a ground plane 6 too hastily, horizontal level b2-f2-g2-h2-i2-e2 are crooked by four places so that it may illustrate, and the tip is opened wide. The crookedness in this inside passive element 2 is crooked so that the inside passive element 2 may hold a fixed gap and may become parallel in a field parallel to a ground plane 6 at the electric supply element 1. In addition, only the gap equivalent to the length of vertical section a2-b2 is isolated from a ground plane 6, and the inside passive element 2 is arranged in parallel with the field of a ground plane 6.
[0017] Furthermore, a3 point of vertical section a3-b3 of the outside passive element 3 is connected with a ground plane 6 too hastily, horizontal level b3-f3-e3 are crooked by one place so that it may illustrate, and the tip is opened wide. The crookedness in this outside passive element 3 is crooked so that the outside passive element 3 may hold a fixed gap and may become parallel in a field parallel to a ground plane 6 at the electric supply element 1. In addition, only the gap equivalent to the length of vertical section a3-b3 is isolated from a ground plane 6, and the outside passive element 3 is arranged in parallel with the field of a ground plane 6. Moreover, it is made for the starting points b1, b2, and b3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 to be located on the A-A line which is a straight line, and they are arranged in the location which exceeded the A-A line so that the folding point h2 in the inside passive element 2 and folding point i2 might illustrate.
[0018] by the way, vertical section a1- of the electric supply element 1 -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 -- the length of a conductor 5 is made almost equal to mutual, and is made almost equal by the length of horizontal level b1-f1-g1-e1 of the electric supply element 1, and the length of horizontal level b3-f3-e3 of the outside passive element Moreover, the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set up for a long time than the length of horizontal level b1-f1-g1-e1 of the electric supply element 1. for example, the time of setting wavelength of layout frequency 1.2 [GHz] to lambdao -- vertical section a1- of the electric supply element 1 -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of an inside passive element, and an outside passive element -- the length of a conductor 5 It is referred to as about 0.0912lambdao, the length of horizontal level b3-f3-e3 of horizontal level b1-f1-g1-e1 and the outside passive element 3 of the electric supply element 1 is set to about 0.176lambdao, and the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set to about 0.223lambdao. moreover, a short circuit -- length a1-d of a conductor 5 and the feeding point a1 is set to about 0.0352lambdao, and gap a1-a3 of gap a1-a2 with the electric supply element 1 and the inside passive element 2, and the electric supply element 1 and the outside passive element 3 are set to about 0.013lambdao. furthermore, the

electric supply element 1 and the inside passive element 2, the outside passive element 3, and a short circuit -- a conductor 5 -- about [for example, / diameter] -- it consists of wire rods of 0.004lambdao.

[0019] It is crooked so that the length until it touches an A-A line from the length of b2-f2 in the horizontal level of the inside passive element 2 and the length of f2-g2 in the 1st reverse female mold antenna of this invention shown in drawing 1 (a) and (b), and g2 may become almost equal. The electrical characteristics at the time of making the above-mentioned electric supply element 1 and the above-mentioned outside passive element 3 of element length crooked are shown in drawing 2 and drawing 3 so that a fixed gap may be held and it may become parallel in a field parallel to a ground plane 6 to this inside passive element 2. However, drawing 2 is the Smith chart which shows the impedance characteristic of a reverse female mold antenna, and drawing 3 shows the frequency characteristic of VSWR. Moreover, the radiation pattern in phi= 0-degree side is shown in drawing 8 . Although VSWR shows the orientation made some in low-pass for 2 minutes when drawing 2 and drawing 3 are referred to, it turns out that the fractional bandwidth from which VSWR becomes three or less is made into about 29% of broadband. Thus, since the 1st reverse female mold antenna of this invention can make a fractional bandwidth a broadband even if it is crooked in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 and attains a miniaturization, it can be applied to the communication system for which a miniaturization and broadband nature, such as a portable telephone, are needed, and can be used as a suitable antenna.

[0020] Here, why the frequency characteristic of VSWR becomes a broadband like the conventional example the 1st reverse female mold antenna of this invention indicates the electric supply element 1 and two passive elements 2 and 3 to be to drawing 12 (b) even if crooked in a field parallel to a ground plane 6, without being carried out for 2 minutes is explained. When the reverse female mold antenna of a configuration of being shown in drawing 12 (a) was analyzed by various technique, the frequency characteristic containing the low-pass resonance frequency fL shown in drawing 12 (b) is done so by operation of the passive element 112 arranged outside, and it turned out that the frequency characteristic near the resonance-frequency fH of the lower one in the high region which is shown in drawing 12 (b) and which was carried out for 2 minutes is done so by operation of the passive element 113 arranged inside. Furthermore, the frequency characteristic of the broadband in the high region carried out by the operation with the electric supply element 111 and a passive element 113 for 2 minutes is done so. Here, if resonance frequency fH is shifted to low-pass, since resonance frequency fH approaches resonance frequency fL, the frequency characteristic can be made into the frequency characteristic of a broadband, without being carried out for 2 minutes. In order to realize this, he lengthens the element length of the inside passive element 2, and is trying to shift resonance frequency fH to low-pass with the 1st reverse female mold antenna of this invention.

[0021] Next, the 2nd example of a configuration of the gestalt of operation of the reverse female mold antenna of this invention is shown in drawing 4 and drawing 5 . However, drawing 4 is the perspective diagram of the 2nd reverse female mold antenna of this invention, and drawing 5 is the plan of the 2nd reverse female mold antenna of this invention. The 2nd reverse female mold antenna shown in drawing 4 and drawing 5 is considered as a different configuration from the 1st reverse female mold antenna shown in drawing 1 (a) and (b) the following point. With the 1st reverse female mold antenna of this invention shown in drawing 1 (a) and (b), it is made for the starting points b1, b2, and b3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 to be located on an A-A line, and they are arranged in the location which exceeded the A-A line so that the folding point h2 in the inside passive element 2 and folding point i2 might illustrate. On the other hand, the 2nd reverse female mold antenna shown in drawing 4 and drawing 5 While making it the starting points b1, b2, and b3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 located on an A-A line Horizontal level b2-f2-g2-h2-i2-e2 are crooked so that it may illustrate and the folding point h2 in the inside passive element 2 and folding point i2 may also be stationed in the location on an A-A line.

[0022] In other configurations, since the 2nd reverse female mold antenna of this invention is

considered as the same configuration as the 1st reverse female mold antenna of this invention, the explanation is omitted. The length of a conductor 5 is made almost equal to mutual. vertical section a1- of the electric supply element 1 in the 2nd reverse female mold antenna of this this invention -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 -- It is made almost equal by the length of horizontal level b1-f1-g1-e1 of the electric supply element 1, and the length of horizontal level b3-f3-e3 of the outside passive element 3. Moreover, the length of the horizontal level of the inside passive element 2 is set up for a long time than the length of horizontal level b1-f1-g1-e1 of the electric supply element 1. for example, the time of setting wavelength of layout frequency 1.2 [GHz] to lambdao -- vertical section a1- of the electric supply element 1 -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 -- the length of a conductor 5 It is referred to as about 0.0912lambdao, the length of horizontal level b3-f3-e3 of horizontal level b1-f1-g1-e1 and the outside passive element 3 of the electric supply element 1 is set to about 0.176lambdao, and the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set to about 0.223lambdao. moreover, a short circuit -- length a1-d of a conductor 5 and the feeding point a1 is set to about 0.0352lambdao, and gap a1-a3 of gap a1-a2 with the electric supply element 1 and the inside passive element 2, and the electric supply element 1 and the outside passive element 3 are set to about 0.013lambdao. furthermore, the electric supply element 1 and the inside passive element 2, the outside passive element 3, and a short circuit -- a conductor 5 -- about [for example, / diameter] -- it consists of wire rods of 0.004lambdao.

[0023] Are crooked so that the length of b2-f2 in the horizontal level of the inside passive element 2 and the length of f2-g2 in the 2nd reverse female mold antenna of this invention shown in drawing 4 and drawing 5 , and the length of g2-h2 may become almost equal, and this inside passive element 2 is received. The electrical characteristics at the time of making the above-mentioned electric supply element 1 and the above-mentioned outside passive element 3 of element length crooked are shown in drawing 6 , drawing 7 , and drawing 8 so that a fixed gap may be held and it may become parallel in a field parallel to a ground plane 6. However, drawing 6 is the frequency characteristic of VSWR of a reverse female mold antenna, and drawing 7 is the Smith chart which shows the impedance characteristic. When drawing 6 and drawing 7 are referred to, the orientation of VSWR almost carried out in low-pass for 2 minutes is lost, and it turns out that the fractional bandwidth from which VSWR becomes three or less is made into about 27% of broadband. Thus, since the 2nd reverse female mold antenna of this invention can make a fractional bandwidth a broadband even if it is crooked in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 and attains a miniaturization, it can be applied to the communication system for which a miniaturization and broadband nature, such as a portable telephone, are needed, and can be used as a suitable antenna.

[0024] Although it explained that the electric supply element 1 and the inside passive element 2, and the outside passive element 3 of a reverse female mold antenna concerning above-mentioned this invention were constituted from a wire rod, this invention can also be formed with the filament which consists not only of this but of metal material, a long and slender band-like board or a long and slender band-like pipe, etc. By the way, also when forming the reverse female mold antenna applied to this invention with which material, it is difficult [it] to constitute so firmly that it continue maintaining horizontally by the necessary mechanical strength the posture of each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2, and the outside passive element 3, in view of the size and reinforcement of the material. Then, in order to solve this, while making a spacer with a low dielectric constant intervene between the electric supply element 1 and the inside passive element 2, the outside passive element 3, and a ground plane 6 and fixing the inferior surface of tongue of this spacer to the surface of a ground plane 6, you may make it fix the electric supply element 1 and the inside passive element 2, and the outside passive element 3 of a reverse female mold antenna on the upper surface of a spacer. in this case, each vertical section in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 is fixed on the side of a spacer, and a spacer is penetrated -- as -- a short circuit -- what is

necessary is just to attach a conductor 5 Thereby, a mechanical strength being enlarged and maintaining the posture of each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2, and the outside passive element 3 can be continued in parallel to a ground plane 6.
[0025] Moreover, the perimeter of the through tube which countered the feeding point a1 and was formed in the ground plane 6 is filled up with an insulating material with a good RF property, and you may make it the central conductor of a plug not contact a ground plane 6. Furthermore, each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2 concerning this invention, and the outside passive element 3 is formed by the metal thin layer formed in the upper surface of a rectangular parallelepiped-like dielectric with means, such as vacuum evaporationo, and each vertical section of the electric supply element 1 and the inside passive element 2, and the outside passive element 3 is formed with the same means as the side of a dielectric. forming a metal thin layer in addition with the means by which it is the same in the through tube prepared in the dielectric, furthermore -- a short circuit -- a conductor 5 is formed. And you may make it constitute the reverse female mold antenna of this invention by fixing the metal plate of predetermined area on the inferior surface of tongue of a dielectric, or forming a metal thin layer throughout the inferior surface of tongue of a dielectric, and considering as a ground plane 6.
[0026] the 1st reverse female mold antenna of this invention which gave [above-mentioned] explanation -- setting -- a short circuit -- although length a1-d of a conductor 5 and the feeding point a1 is set to about 0.0352lambdao, change of the electrical characteristics at the time of making this length a1-d into a parameter is shown in drawing 9 and drawing 10 . drawing 9 (a) -- a short circuit -- it is the Smith chart which shows the impedance characteristic of the reverse female mold antenna at the time of setting length a1-d of a conductor 5 and the feeding point a1 to about 0.02lambdao, and drawing 9 (b) shows the frequency characteristic of the VSWR. When drawing 9 (a) and (b) are referred to, the orientation of VSWR carried out in low-pass for 2 minutes is strong, and its fractional bandwidth is also narrow. Moreover, as compared with the impedance characteristic shown in drawing 7 , the impedance characteristic is also changing so that clearly.
[0027] moreover, drawing 10 (a) -- a short circuit -- it is the Smith chart which shows the impedance characteristic of the reverse female mold antenna at the time of setting length a1-d of a conductor 5 and the feeding point a1 to about 0.052lambdao, and drawing 10 (b) shows the frequency characteristic of the VSWR. When drawing 10 (a) and (b) are referred to, the orientation for VSWR to be carried out in low-pass for 2 minutes is small, and three or less fractional bandwidth also has large VSWR. Moreover, as compared with the impedance characteristic shown in drawing 7 , the impedance characteristic is also changing so that clearly. the short circuit set to about 0.0352lambdao by which instantiation was carried out [above-mentioned] -- length a1-d of a conductor 5 and the feeding point a1 is made into the numeric value of the between in the case of being shown in drawing 9 and drawing 10 , and it becomes a property also with the good impedance characteristic while the fractional bandwidth larger than the fractional bandwidth shown in drawing 9 and drawing 10 is obtained. thus, a short circuit -- carrying out near the illustrated numeric value is suitable for length a1-d of a conductor 5 and the feeding point a1.
[0028]
[Effect of the Invention] Since the length of the passive element located inside is lengthened when the reverse female mold antenna of this invention is constituted as mentioned above and an electric supply element and two passive elements are made to be crooked in a field parallel to a ground plane, it can consider as the reverse female mold antenna which has broadband nature, without carrying out a clock frequency band for 2 minutes. Moreover, since an electric supply element and two passive elements are crooked, they can be used as a small reverse female mold antenna.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] They are the perspective diagram showing the configuration of the 1st example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention, and a plan.
[Drawing 2] It is the Smith chart which shows the impedance characteristic of the 1st reverse female mold antenna of this invention.
[Drawing 3] It is drawing showing the frequency characteristic of VSWR of the 1st reverse female mold antenna of this invention.
[Drawing 4] It is the perspective diagram showing the configuration of the 2nd example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention.
[Drawing 5] It is the plan showing the configuration of the 2nd example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention.
[Drawing 6] It is drawing showing the frequency characteristic of VSWR of the 2nd reverse female mold antenna of this invention.
[Drawing 7] It is the Smith chart which shows the impedance characteristic of the 2nd reverse female mold antenna of this invention.
[Drawing 8] It is drawing showing the radiation pattern of the 1st reverse female mold antenna of this invention.
[Drawing 9] the reverse female mold antenna of this invention -- setting -- a short circuit -- it is the Smith chart which shows the impedance characteristic at the time of changing the location of a conductor to the feeding point.
[Drawing 10] the reverse female mold antenna of this invention -- setting -- a short circuit -- it is the Smith chart which shows other impedance characteristics at the time of changing the location of a conductor to the feeding point.
[Drawing 11] It is drawing showing the configuration of the conventional reverse female mold antenna, the frequency characteristic of VSWR, and a radiation pattern.
[Drawing 12] It is drawing showing the configuration of other conventional reverse female mold antennas, the frequency characteristic of VSWR, and a radiation pattern.
[Description of Notations]
1,101,111 Electric supply element
2 Inside Passive Element
3 Outside Passive Element
4,104,114 Electric supply section
5,105,115 a short circuit -- conductor
6,106,116 Ground plane
112,113 Passive element

[Translation done.]

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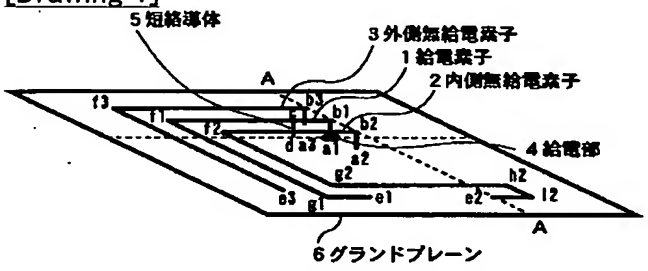
DRAWINGS

[Drawing 1]



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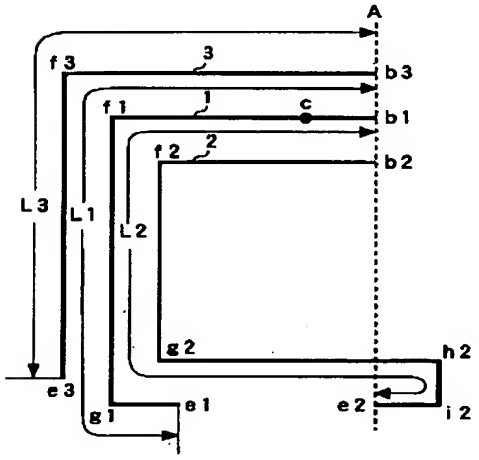
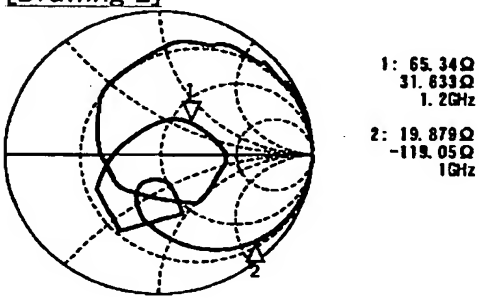


(b)

[Drawing 2]



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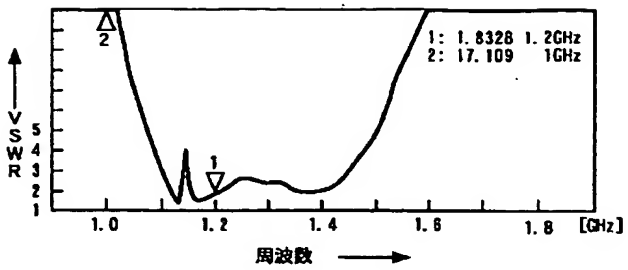

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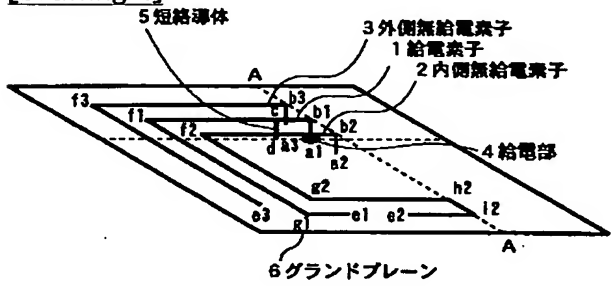

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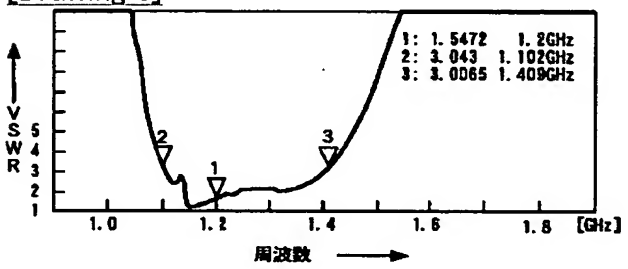

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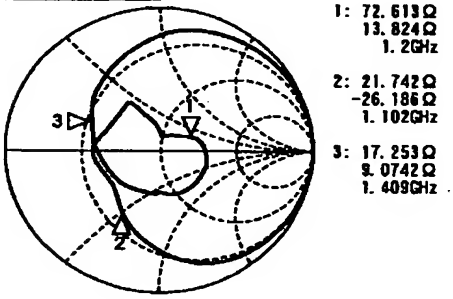

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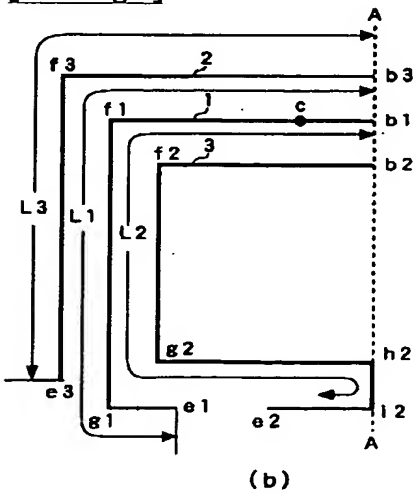
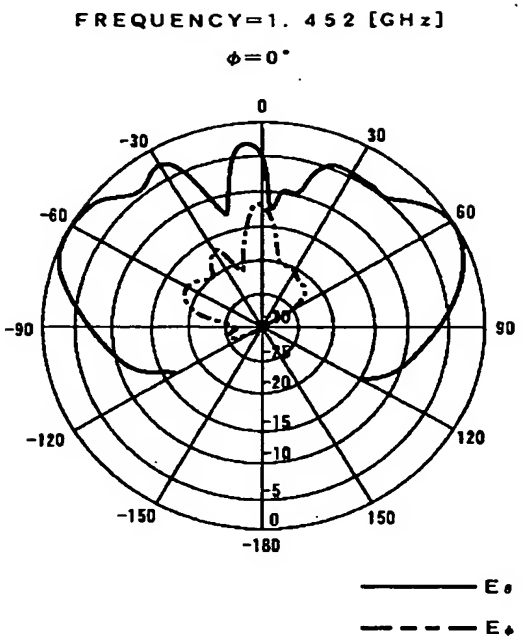


[Drawing 8]



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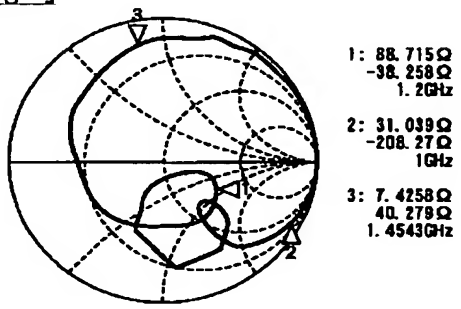

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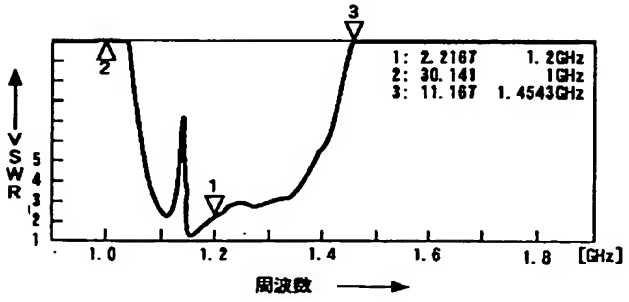
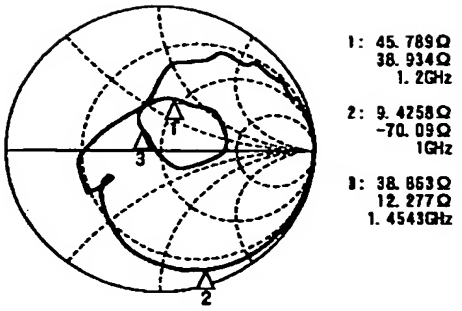


(b)

[Drawing 10]



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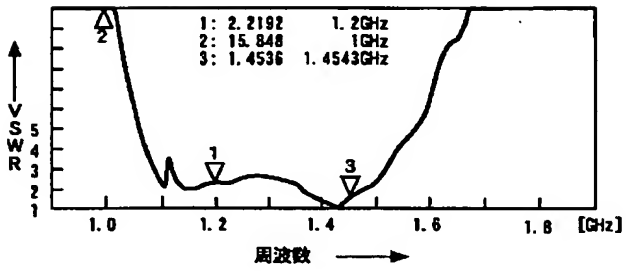
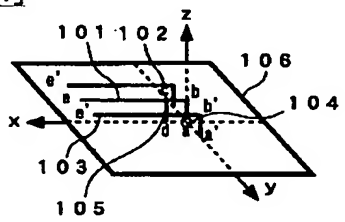


(b)

[Drawing 11]

(a)



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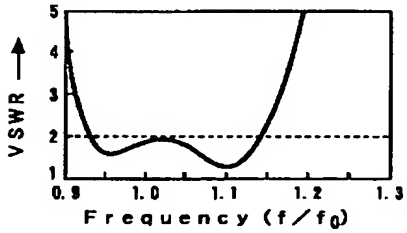

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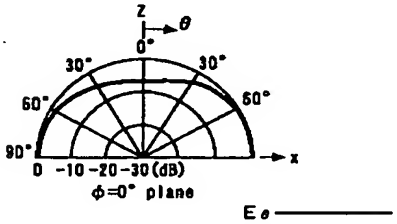

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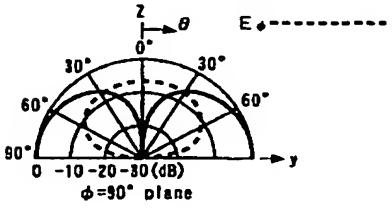
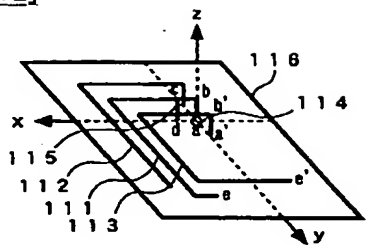


[Drawing 12]

(a)



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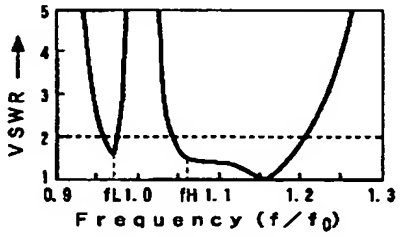

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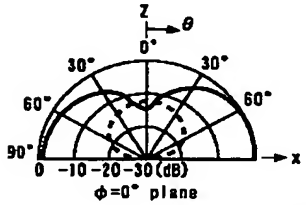

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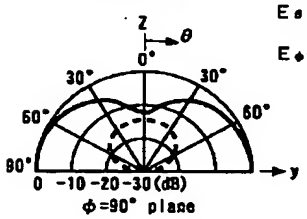

[Translation done.]